

NASA TECH BRIEF



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Machining Heavy Plastic Sections

The problem:

Pressure windows, 24 by 48 inches, with a thickness of 2.5 inches, were required to support a photographic study of liquid rocket combustion processes. This necessitated machining and polishing the opposing surfaces of the plates to sufficiently close tolerances to obtain satisfactory optical characteristics. Conventional machining methods produced severely distorted surfaces as a result of time-dependent stress relaxation after completion of the parts. The material involved was Plexiglass, a transparent polymer. The distortion was found to derive from two distinct sources. First, although the material had been annealed, severe residual stresses were found in the raw material. Also, heat and mechanical loads imposed during machining added to the original stresses.

The solution:

A machining technique was developed that resolved both these problems and permitted fabrication of parts with plane-parallel surfaces with satisfactory optical properties.

How it's done:

A number of unconventional techniques were employed to ensure distortion-free surfaces on the finished parts. The machining was accomplished on a vertical spindle mill. A carefully balanced double flycutter of sufficient length to sweep the stock width with two 180-degree opposed cutting bits was prepared.

The stock was laid on the milling table and held down by its own weight. The ends and sides were blocked, NOT clamped, to prevent lateral movement.

The blocking was firm to prevent vibration and chatter, but did not impose any measurable compressive load on the stock.

The depth of cut was stringently limited to less than 0.060 inch per pass (nominal 0.050 inch from touch-off). The stock was turned over on the table between each pass so that material was removed evenly from both sides. Minimum feedrate was used to minimize heat buildup in the stock. Each cut was continuous, i.e., no interruption of cutter rotation or table travel was permitted between the start and finish of any pass. When the thickness reached 0.030 inch over the finish dimension, the stock was removed from the machine and allowed to relax for a minimum of 48 hours. During this period it was stored on edge with no restraint of any type and no protection from the ambient conditions in the shop. It was then returned to the mill and one-half of the remaining surplus (0.015 inch) was removed from each side. This was followed by polishing, using conventional processes and taking care not to allow any heat buildup in the part.

Notes:

1. This program is found to produce consistently satisfactory plane-parallel optical surfaces that are not subject to degradation from stress relaxation over periods as long as 6 months. No data is available for longer storage periods at this time.
2. Inquiries concerning this invention may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B67-10381

(continued overleaf)

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: O. M. Stalkup
of North American Aviation, Inc.
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Marshall Space Flight Center
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